EXHIBIT B

FOAM WAFER CLEANING EXPERIMENTAL PROOF OF CONCEPT

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Introduction

The background information describing foam based semiconductor wafer cleaning has been presented previously (1) eliminating the need for review here.

Objectives

(1) Demonstrate that a liquid composition delivered to a semiconductor wafer substrate can provide cleaning results equivalent to the same composition used on the wafer in the liquid phase.
(2) Demonstrate that only collapsing aqueous foam bubbles are capable of cleaning semiconductor wafer substrates, without the use of cleaning compositions, in a manner analogous to ultra- or megasonics cleaning.

Conclusions

(1) Chemical cleaning compositions delivered to a semiconductor wafer substrate in either a liquid or foam medium produce equivalent cleaning results.
(2) A dilute surfactant solution, without any chemical cleaning agents, will not clean a semiconductor wafer substrate in a condensed liquid phase, but the foam generated from the injection of gas into this liquid will clean the wafer as well as the cleaning compositions.
(3) These preliminary experiments confirm that collapsing aqueous foam bubbles provide a powerful cleaning action with extremely low chemical usage.
(4) These preliminary experiments strongly suggest that aqueous foam is a likely substitute for ultra- or megasonics cleaning.

Discussion

The objective of these experiments was to show relative, or comparative, cleaning, liquid phase vs. foam phase. In some instances the absolute cleaning was very good and in other cases just average.

The first six SEM photographs show the "T" wafer with EKC 640. The percentage of cleaning is high and the liquid (beaker) and foam results are equivalent.

All the remaining SEM photographs show the "S" wafer.

Photographs 7-12 compare the surfactant only system to the unprocessed wafers. In this case, the liquid (beaker) results show essentially no cleaning, while the foam results are dramatically superior.

Photographs 13-16 show EKC 640 at thirty minutes exposure. Both cases, liquid (beaker) and foam, are cleaned, equivalently, but not completely.

Photographs 17-20 show EKC 640D using a 5 minute clean, followed by a one minute rinse, followed by another five minute clean – very good cleaning in both cases.

Photographs 21-25 are other EKC 640D cleans with various time sequences, showing reasonable cleaning in both cases.

Photographs 26-28 show EKC BHX foam cleaning only. The results are very good.

Experimental

Two different proprietary wafers were used in the cleaning experiments. Each wafer surface was contaminated with photomask residue from the previous removal process. The wafers are designated "T" or "S" and their unprocessed initial condition is characterized in the SEM pictures provided in the Appendix of this report.

Three chemical cleaning compositions were used in both the liquid phase and the foam phase – EKC 640, EKC 640D, and EKC BHX002. These compositions are proprietary.

Two surfactants were used in order to make these compositions foamable. The NCW601A was obtained from Wako Chemical (2), and the DDBSA(Na+) was laboratory material obtained from Aldrich. These materials were readily available and no attempt was made to evaluate other surfactant candidates. Since some of the chemical cleaning agents contained relatively low levels of water, the surfactant levels required for foaming had to be quite high. No optimization efforts were made – when the substance foamed, the experimental conditions were defined as satisfied.

The liquid phase cleaning experiments (beakers) involved suspending the wafer fragment, one sq. cm., in 100 cc. of the cleaning medium stirred magnetically at room temperature for the designated time period.

The corresponding foaming compositions were placed in a tall cylindrical vessel equipped with a gas dispersion tube for supplying nitrogen. Proper adjustment of the gas flow generated a foam "head" above the liquid phase. The wafer fragment was suspended in this foam for the designated time period.

When the treatment process was completed the wafer fragments were rinsed with DI water for two minutes and dried with nitrogen gas.

Table One provides a summary of the cleaning compositions and the experimental conditions as well as the reference to the SEM photograph.

SEM analysis provided the results.

References

(1) Kittle, Paul A., "Particulate Removal Using a Foam Medium," in press, A2C2, September or October, 2001. A more comprehensive and more thoroughly referenced version can be found on the Internet: http://www.aquafoam.com/particulate.html. The technology has been patented, Kittle, Paul A., "Surface Treatment of Semiconductor Substrates," U.S. Patent 6090217, July 18, 2000, as well as the divisional application, now allowed and issuing in the immediate future.

(2) Wako Chemicals USA, Inc., 1600 Bellwood Road, Richmond, VA 23237, 804-271-7677.

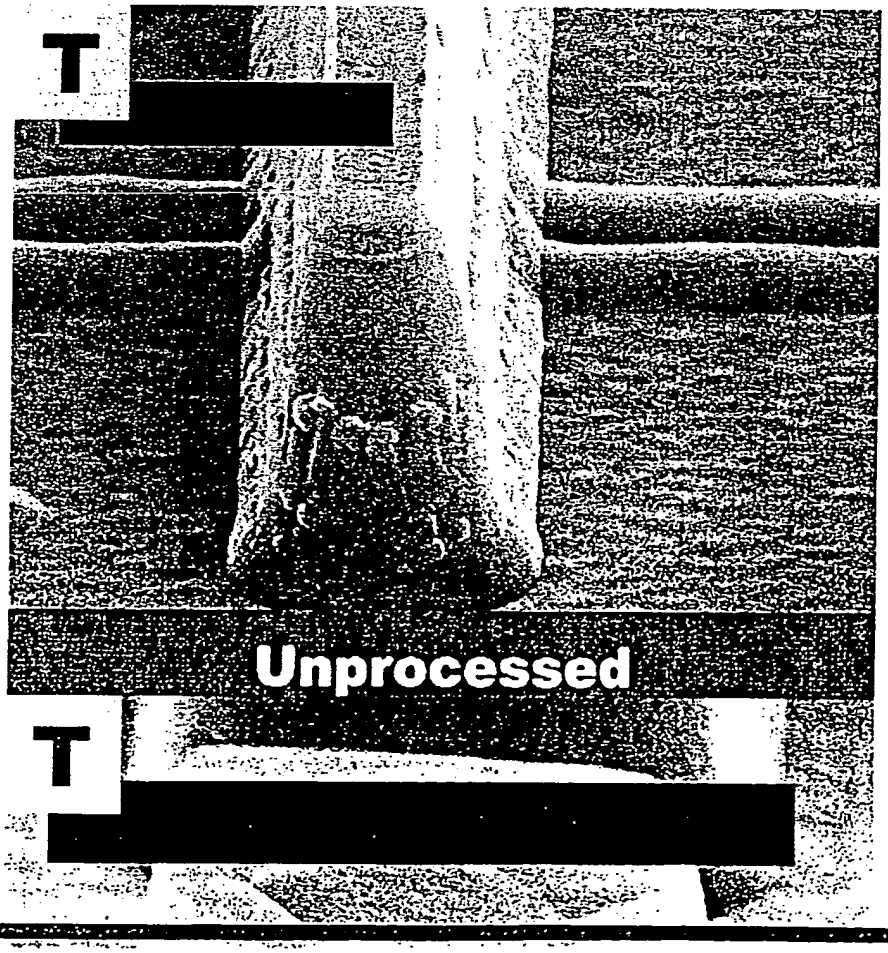
Appendix

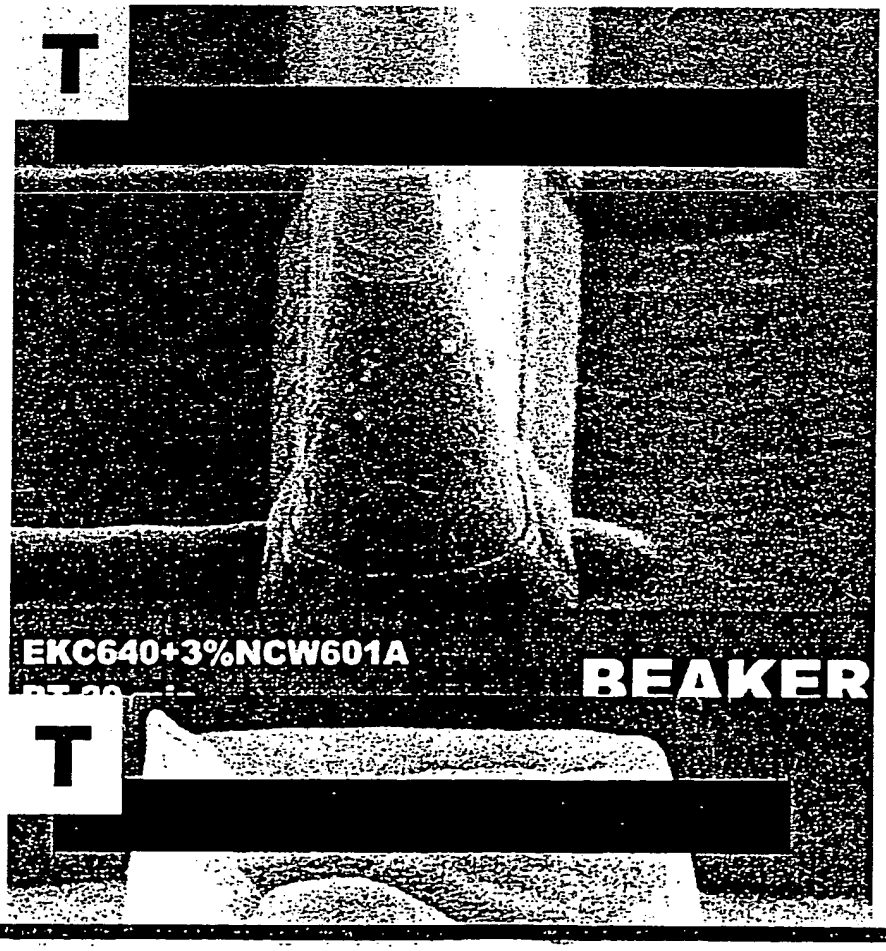
Table One – Cleaning Fluid Composition Summary
Scanning Electron Microscope Results

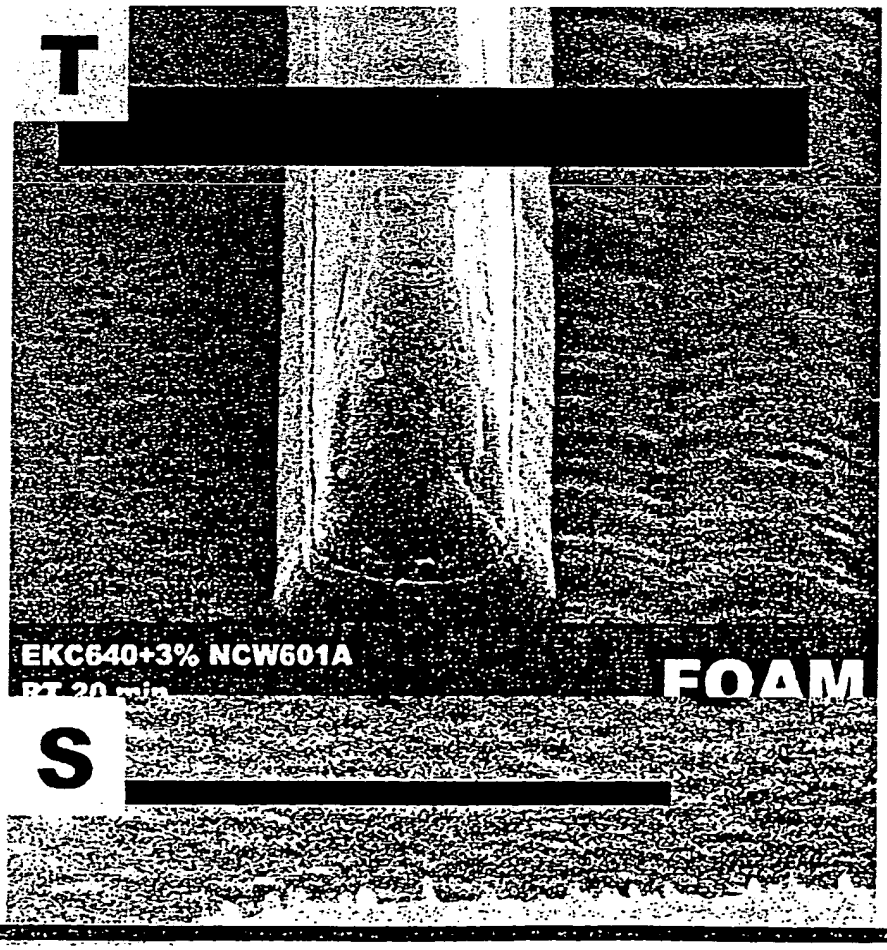
Table One
Foam Wafer Cleaning Report
Cleaning Fluid Composition Summary

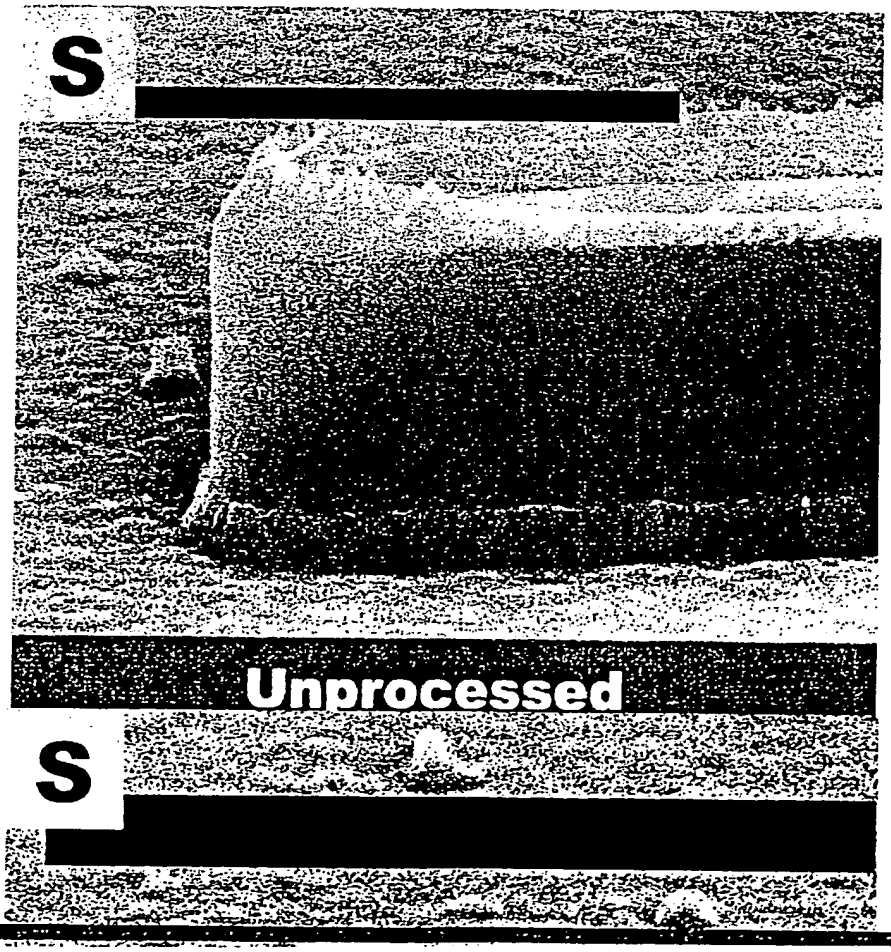
SEM Photo	Wafer	Fluid Medium	EKC Chemical	Surfactant A Name	Surfactant A Wt %	Surfactant B Name	Surfactant B Wt %	Treating Time*
1	T	Unproc.						
2	T	Beaker	640	NCW601A	3.0			20
2	T	Beaker	640	NCW601A	3.0			20
3	T	Foam	640	NCW601A	3.0			20
3	T	Foam	640	NCW601A	3.0			20
4	S	Unproc.						
5	S	Beaker		NCW601A	0.6	DDBSA(Na+)	0.6	10/1/10
5	S	Beaker		NCW601A	0.6	DDBSA(Na+)	0.6	10/1/10
6	S	Foam		NCW601A	0.6	DDBSA(Na+)	0.6	10/1/10
6	S	Foam		NCW601A	0.6	DDBSA(Na+)	0.6	10/1/10
7	S	Beaker	640	NCW601A	3.0			30
7	S	Beaker	640	NCW601A	3.0			30
8	S	Foam	640	NCW601A	3.0			30
8	S	Foam	640	NCW601A	3.0			30
9	S	Beaker	640D			DDBSA(Na+)	3.0	5/1/5
9	S	Beaker	640D			DDBSA(Na+)	3.0	5/1/5
10	S	Foam	640D			DDBSA(Na+)	5.0	5/1/5
10	S	Foam	640D			DDBSA(Na+)	5.0	5/1/5
11	S	Beaker	640D			DDBSA(Na+)	3.0	5/1/5
11	S	Beaker	640D			DDBSA(Na+)	3.0	5/1/5
12	S	Beaker	640D			DDBSA(Na+)	1.5	20
12	S	Beaker	640D			DDBSA(Na+)	1.5	20
13	S	Foam	640D			DDBSA(Na+)	5.0	7/1/7
13	S	Foam	BHX002			DDBSA(Na+)	0.5	10/1/10
14	S	Foam	BHX002			DDBSA(Na+)	0.5	10/1/10
14	S	Foam	BHX002			DDBSA(Na+)	0.5	10/1/10

Note: 10/1/10, etc., denotes treatment time, rinse time, treatment time
Final rinse, at least two minutes, followed by nitrogen gas drying
All experiments at room temperature
NCW601A, nonionic
DDBSA(Na+), anionic


T
Unprocessed
T


T
EKC640+3%NCW601A
BEAKER
T


T
EKC640+3% NCW601A
FOAM
S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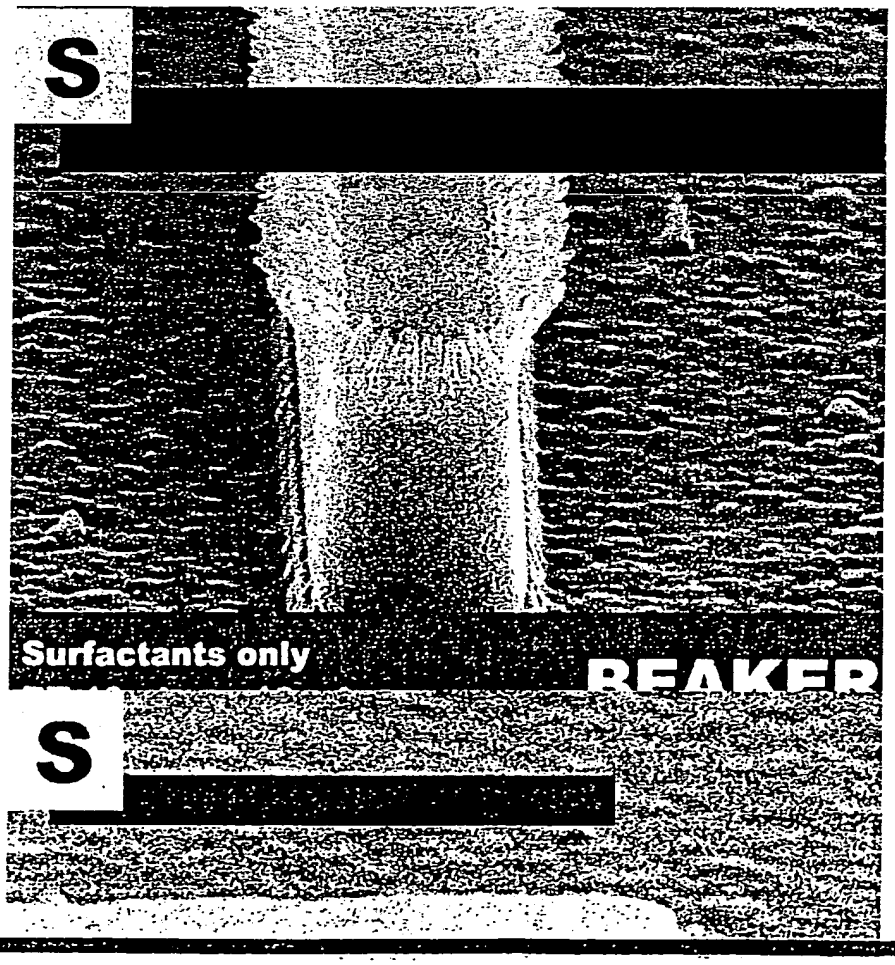
Unprocessed
S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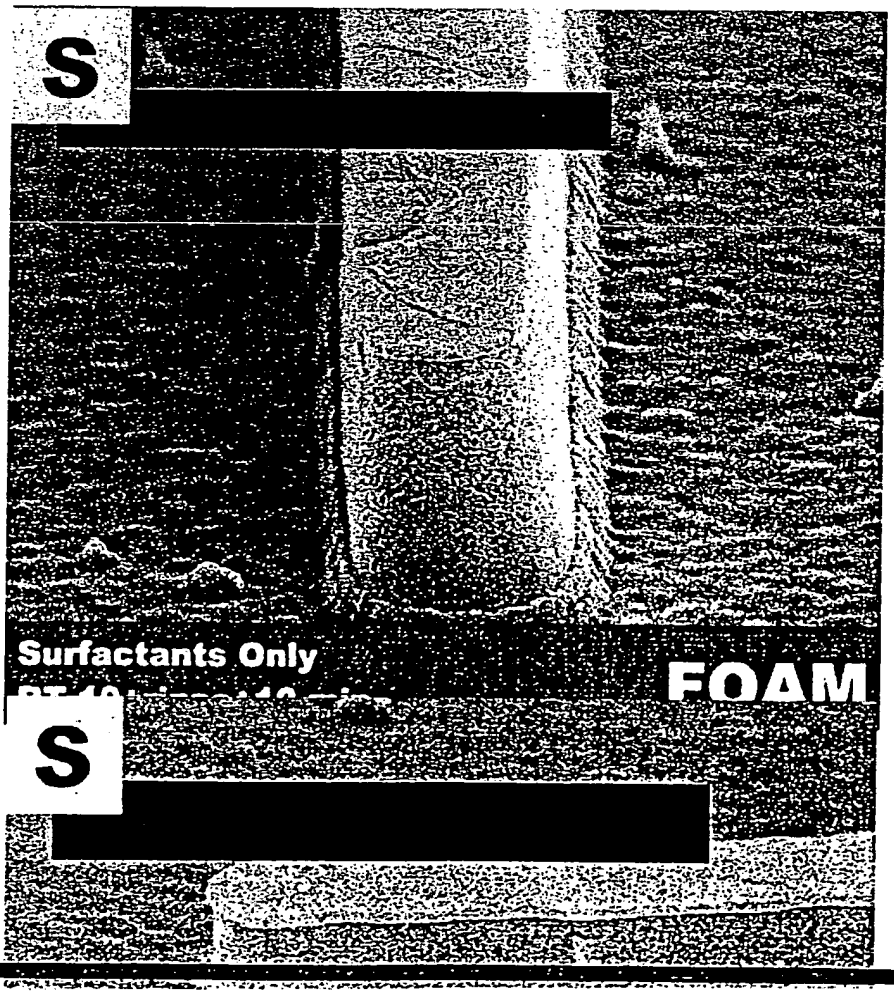
Surfactants only
BEAKER
S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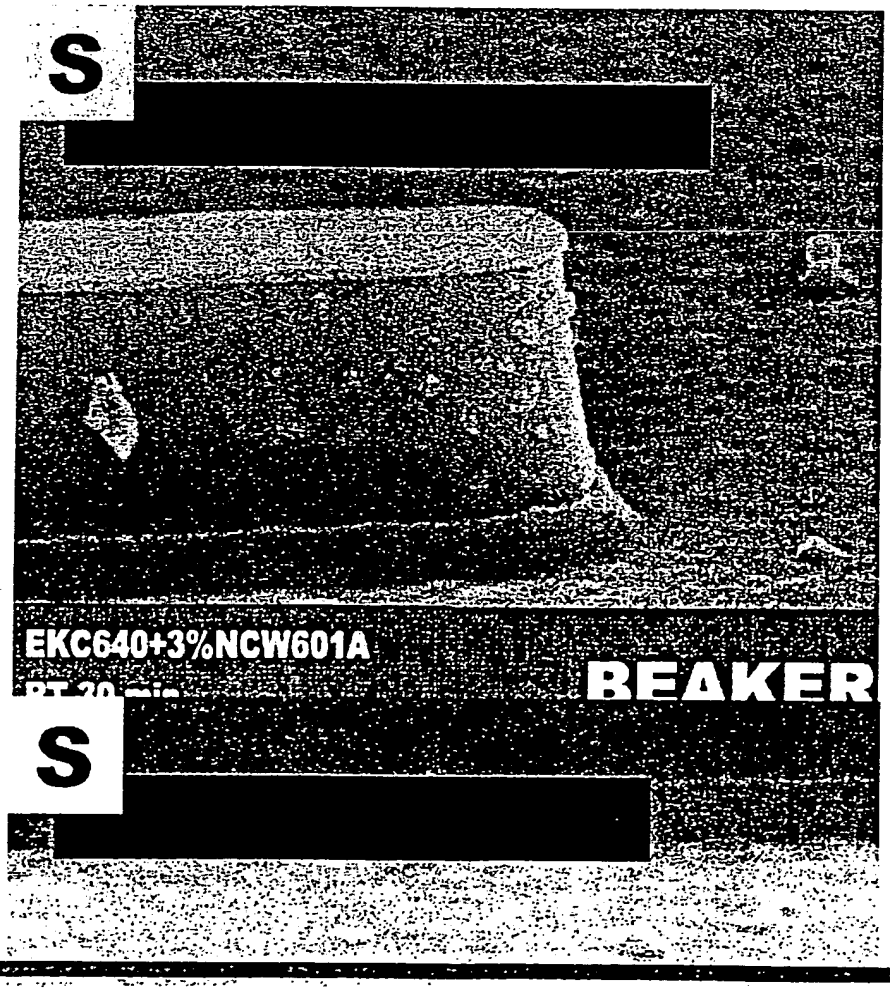
Surfactants Only
FOAM
S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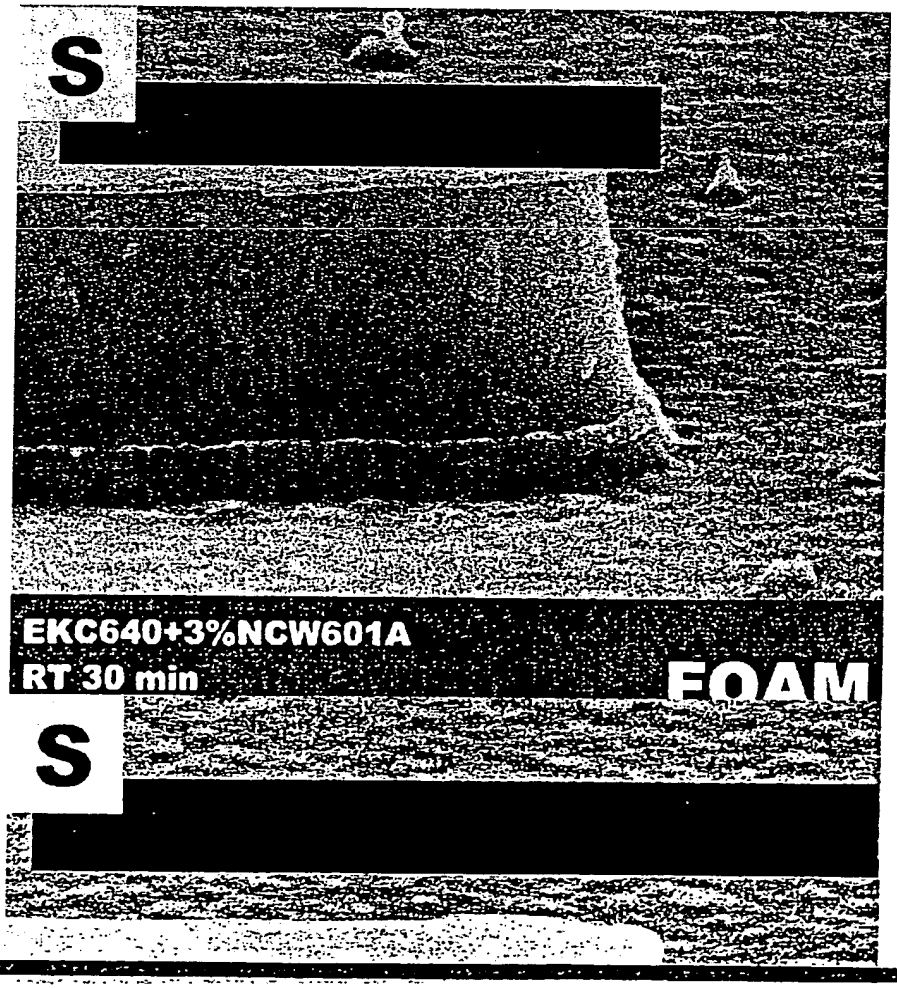
EKC640+3%NCW601A
BEAKER
S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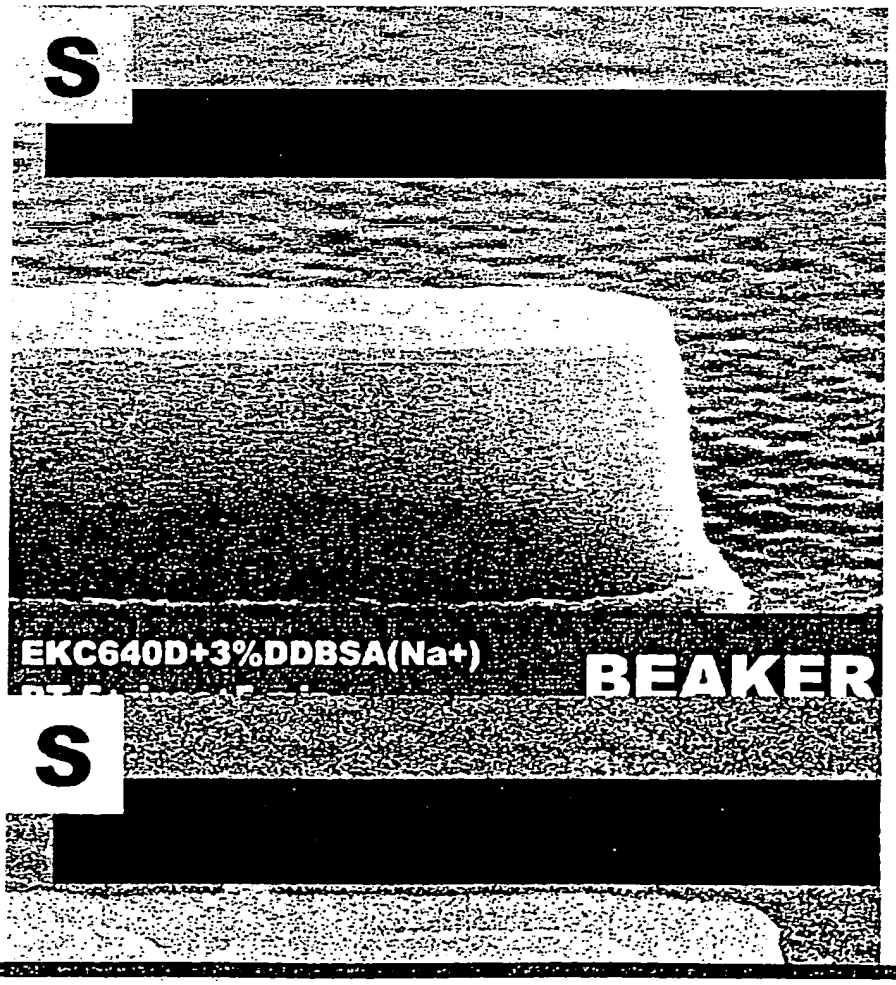
EKC640+3%NCW601A
RT 30 min
FOAM
S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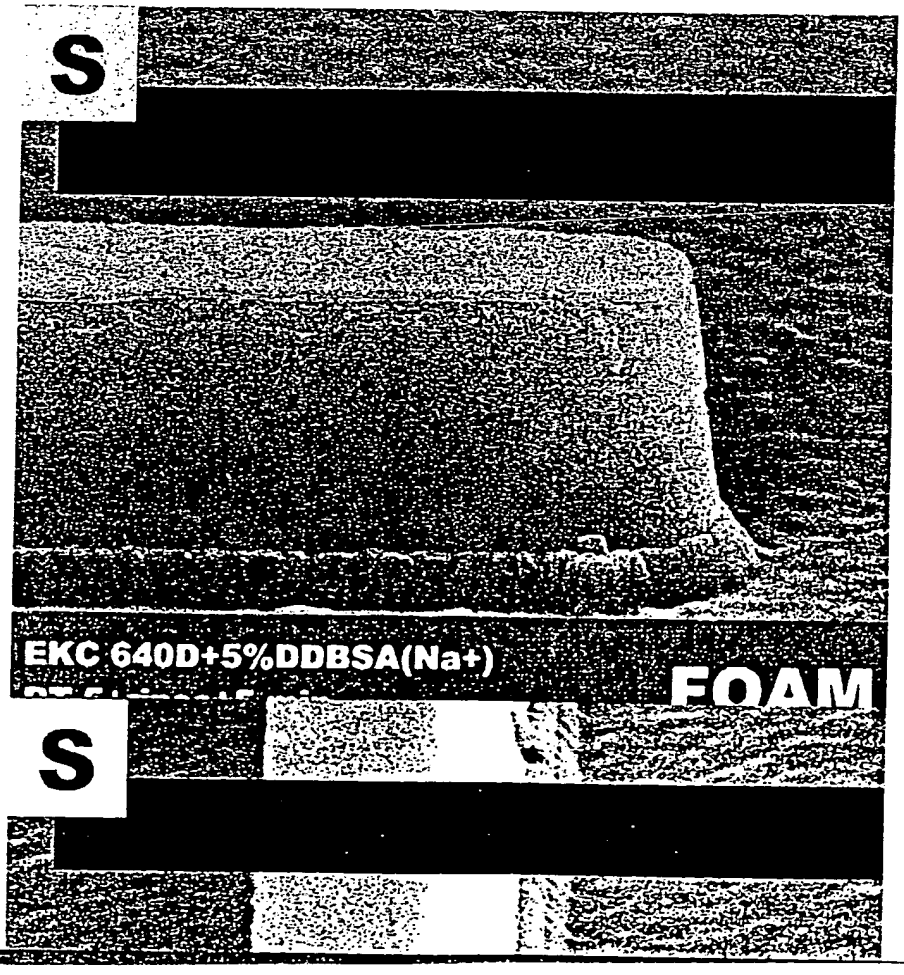
EKC640D+3%DDBSA(Na+)
BEAKER
S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EKC 640D+5%DDBSA(Na+)
FOAM
S